The limits of spaceborne SAR geolocation: Can we attain the 1 cm level?

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Assigning precise coordinates to spaceborne 2-D SAR images is crucial when combining the data with other sources of geo-localized information like optical images, road networks or GIS data in general. The range-Doppler principle underlying the SAR images readily allows for direct geolocation of SAR products and the satellite providers have adjusted their processing chains by geometrical calibration to ensure geolocation at half of the product resolution or better.

In the case of bright artificial point targets, however, geolocation may be carried out far beyond the average product resolution and it provides the key to an overall geometrical consistency across different products or even different SAR missions. To achieve this, all the elements involved in a SAR image acquisition – orbit determination, payload calibration, image processing, atmospheric path delay correction, solid Earth surface signal correction – have to be treated with meticulous care. In the framework of the ESA commissioned project “Fiducial Reference Measurements for SAR Geometric Calibration and Performance Assessment” (FRM4SAR), we have documented and tested these elements. Based on our experience gathered with Sentinel-1 and TerraSAR-X, we will demonstrate how this task can be solved down to the low centimeter level. Potentially, the range and azimuth coordinates of point targets could even become as accurate as 1 cm.

Long-term stable corner reflectors (CRs) with accurately known reference coordinates enable verification and cross-comparison of the geolocation capabilities. Using our CR installations in Europe and the large CR array located at the Surat Basin, Australia, we address the crucial elements of accurate geolocation processing, and share our latest results for Sentinel-1 and TerraSAR-X. Particularly the CR array in Australia consisting of 40 individual CRs distributed across a large area allows for detailed spatial probing of SAR products which reveals the limitations in SAR processing employing common approximations.

Tackling such shortcomings in the processing and agreeing on standards in correcting geometrical SAR observation opens new applications for spaceborne SAR and we hope that our findings with Sentinel-1 and TerraSAR-X will be of use to both ongoing and future SAR missions.

References

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